IX. RECHARGE PROJECT SITE ASSESSMENT AND CAPACITY ANALYSIS

The Regional Recharge Committee evaluated potential and existing recharge projects in detail. It selected 16 recharge projects for further evaluation. Evaluations were based on technical and economic criteria, and the projects' regional benefits were described. These 16 projects were used as a preliminary list of potential project sites to be assessed to determine the extent to which they meet Regional Recharge Plan objectives. IPAG decided to eliminate the Tangerine Road at I-10 (basins) site from consideration and to add the Kai at Picacho (indirect) and Pascua Yaqui (basins) sites. A map of existing and proposed recharge projects is included as Figure 5. A longer list of proposed projects, regardless of the amount of analysis completed on them or their current state of development, is included as Appendix G.

A. Assessment Criteria

Assessment criteria were developed based on the objectives of potential recharge participants, including AWBA, as identified through the interview process. They also incorporate IPAG discussions on distinguishing short-term from long-term objectives. Each of the 17 projects evaluated was described in terms of the assessment criteria using information provided in the RRC Technical Report and supplemental information provided by the projects' sponsors, when needed. The criteria used in these project descriptions are listed in Table 8.

B. Categorization of Projects

Rather than rank projects numerically on the basis of the assessments, IPAG elected to categorize projects qualitatively. In order to develop categories of projects, IPAG needed to be able to prioritize the criteria and condense the information in the assessments. These tasks were accomplished by combining individual criteria into three groups: feasibility, capacity, and water management and related benefits. The components of these three groups are displayed in Table 9.

The "feasibility" criteria group was intended to allow the relative ordering of projects based on how certain IPAG could be that they would be built. "Capacity" criteria included total planned capacity and capacity in excess of the projected short-term and long-term needs of the sponsors. "Water management and related benefits" comprised the long-term, location-specific objectives and additional benefits of multiple-use projects. IPAG considered groundwater level decline and subsidence maps to identify areas threatened by continued or increased pumpage in the absence of recharge.

Table 8. Assessment Criteria Used to Evaluate Recharge Projects

Hydrologic Feasibility. The project site and design meet the technical criteria as described in the RRC Report.

Regulatory Compliance. The project has obtained or is likely to qualify for all applicable permits and can comply with all applicable laws and regulations including the Endangered Species Act.

Contaminant Isolation. The project will not mobilize contaminants or exacerbate groundwater contamination.

Acceptability. The project has been approved or is likely to be approved by the governing bodies with jurisdiction over land in the project's area of impact. Local organizations and enterprises are unlikely to object to the project or the project is likely to mitigate local objections.

Speed. The project can be brought into operation within the next three years. (Short-term)

Water Storage Capacity. The project stores a large quantity of water relative to the short-term storage goal; the storage capacity exceeds the minimum, short-term requirements of its sponsors. (Short-term)

Low Cost. The project provides the most economical means to meet its sponsor(s)'s objectives. (Short-term)

Water Supply. The project stores water in the vicinity of future wellfields; the project stores a large quantity of water relative to the long-term storage goal; the project storage capacity exceeds the minimum, long-term requirements of its sponsors. (Long-term)

Storage Credits. The project generates storage credits that can be transferred, recovered or extinguished by the credit owner. Water stored at the project has a high probability of generating credits. (Long-term)

Environmental Enhancement. The project stores water in the vicinity of a riparian/environmental amenity so as to enhance the amenity; the project is designed for riparian/environmental enhancement; the project is accessible to the general public for recreation. (Long-term)

Water Quality Management. The project design provides mitigation/containment of plumes, per a specific remediation plan. The project minimizes any long-term negative water quality impacts of recharge on the aquifer and water customers. (Long-term)

Reduced Overdraft/Cones of Depression and Subsidence Prevention/Mitigation. The project stores water in the vicinity of overdraft and subsidence; the project is designed to mitigate subsidence effects. (Long-term)

Multiple Parties/Multiple Benefits. The project has the support of multiple cooperating sponsors; the project provides multiple benefits to identifiable beneficiaries. (Long-term)

Benefit/Cost. The project costs are appropriate relative to the benefits it provides, including intangible benefits. (Long-term)

Table 9. Project Assessment Groups and Components

FEASIBILITY
Operational and regulatory risk Status of project Conditions imposed by applicable regulations and policies **Acceptability** Equal access Sponsorship potential Community support **Contaminant isolation** **Hydrologic feasibility** Storage potential (Depth to water & groundwater flow) Soil, subsoil, & aquifer characteristics **Cost** Dollars per acre-foot of water recharged ($/AF)
CAPACITY
Total planned capacity **Phase-in of capacity** **Capacity in excess of amount likely to be committed to identified sponsors**
WATER MANAGEMENT AND RELATED BENEFITS
Groundwater level (GWL) change & cone of depression Historical GWL decline Recent GWL change Potential future GWL declines **Subsidence** Calculated subsidence potential Potential impact on infrastructure **Recreational access** **Special needs of location (e.g., trees on Tanque Verde)** **Riparian habitat** **Multiple purposes/multiple beneficiaries** **Shared facilities** **Water quality benefits** **Long-term water balance**

Figure 6 shows maximum potential subsidence relative to existing and proposed recharge sites in the Tucson AMA. Computer models have been used by the USGS to estimate potential for land subsidence in the Tucson AMA (Hanson 1989; Hanson et al., 1990; and Hanson and Benedict, 1994). Results of these studies show that maximum subsidence could reach 12 feet in the Central Wellfield by the year 2025 (Hanson and Benedict, 1994). This estimate is based on the assumption that pumping and natural recharge rates continue at 1986 levels through the year 2025 and that water levels decline more than 400 feet below 1940 water levels. This estimate also depends on assumptions about the aquifer material being compacted. Under these same assumptions, there is potential for up to 4 feet of subsidence in the Santa Cruz Wellfield by the year 2025 (Hanson and Benedict, 1994). Subsidence could reach a maximum of over 14 feet in northern Avra Valley by the year 2025 (Hanson et al., 1990). The Avra Valley estimate is based on the assumption that pumping levels and recharge rates continue at levels experienced in the mid-1970's, and on assumptions made about aquifer material characteristics.

Figure 7 shows historical water level changes from 1940 to 1995. During this period, net maximum water level declines were approximately 150 feet in the Green Valley/Sahuarita area, 150 feet in Avra Valley, and 200 feet in the City of Tucson's Central Wellfield.

Figure 8 shows depth to water in 1994 relative to recharge sites. Depth to water reaches 400 feet in the vicinity of the ASARCO supply wellfield, 300 feet in the Central Wellfield and less than 300 feet in northern Avra Valley.

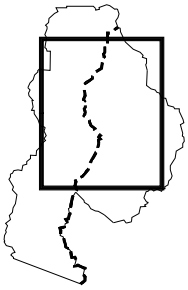
"Cost" was considered as a possible criteria category but was omitted as a separate category because economic factors influence feasibility and were included in the feasibility criteria category. It was extremely difficult to develop comparable cost figures for each project because some projects are still conceptual. In addition, recovery costs are not easily generated as each user may experience different costs.

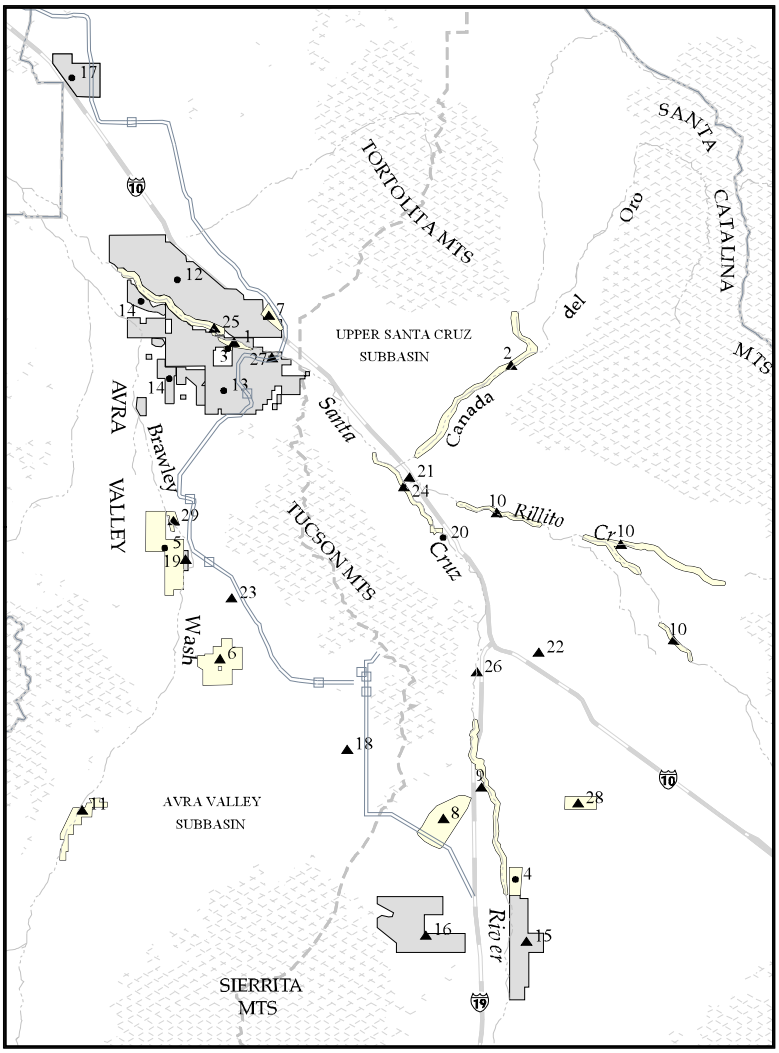
The resulting assessment of projects follows. The highest ranking for Feasibility and for Water Management is Category IV; Category III is the highest grouping for Capacity. The lowest grouping is Category I in all cases.

Feasibility Criterion

Category IV - Projects that have demonstrated their feasibility and are operating.

Avra Valley Recharge Project
BKW Farms Groundwater Savings Project
Cortaro-Marana Irrigation District Groundwater Savings Project
Kai Farms at Picacho Groundwater Savings Project
Avra Valley Irrigation District (AVID) Groundwater Savings Project





Existing

3. Avra Valley Recharge Project
4. Pima Mine Road
5. Central Avra Valley Storage/Recovery Project
12. Cortaro Marana ID
13. BKW Farms
14. Avra Valley ID
17. Kai Picacho
20. Sweetwater

Proposed

1. Lower Santa Cruz River Flood Control/Replenishment
2. Canada del Oro Recharge Project
6. South Avra Valley
7. Tangerine Road West of CAP
8. San Xavier Arroyos
9. Santa Cruz River at San Xavier District
10. Pantano-Tanque Verde-Rillito
11. Brawley Wash
15. FICO - Sahuarita Farms
16. ASARCO - Mission Mine
18. Pascua Yaqui
19. BKW at Mile Wide
21. Tanner Gravel Pit
22. Ajo Detention Basin
23. Avra Valley Gravel Pit
24. Santa Cruz River Managed Project
25. High Plains Effluent Recharge Project
26. Tucson Airport Remediation Project
27. BKW Siphon
28. Bechman
29. Manville-Brawley

- Groundwater Savings Facilities
- Underground Storage Facilities
- Existing Recharge Sites
- Proposed Recharge Sites
- Hardrock
- Tucson AMA Boundary
- Rivers and Streams
- Interstates
- Subbasins
- CAP Canal
- CAP Pumping Stations

Figure 5

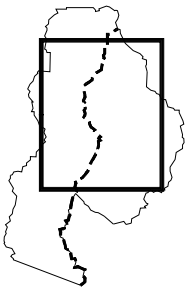
Recharge Sites
Existing and Proposed

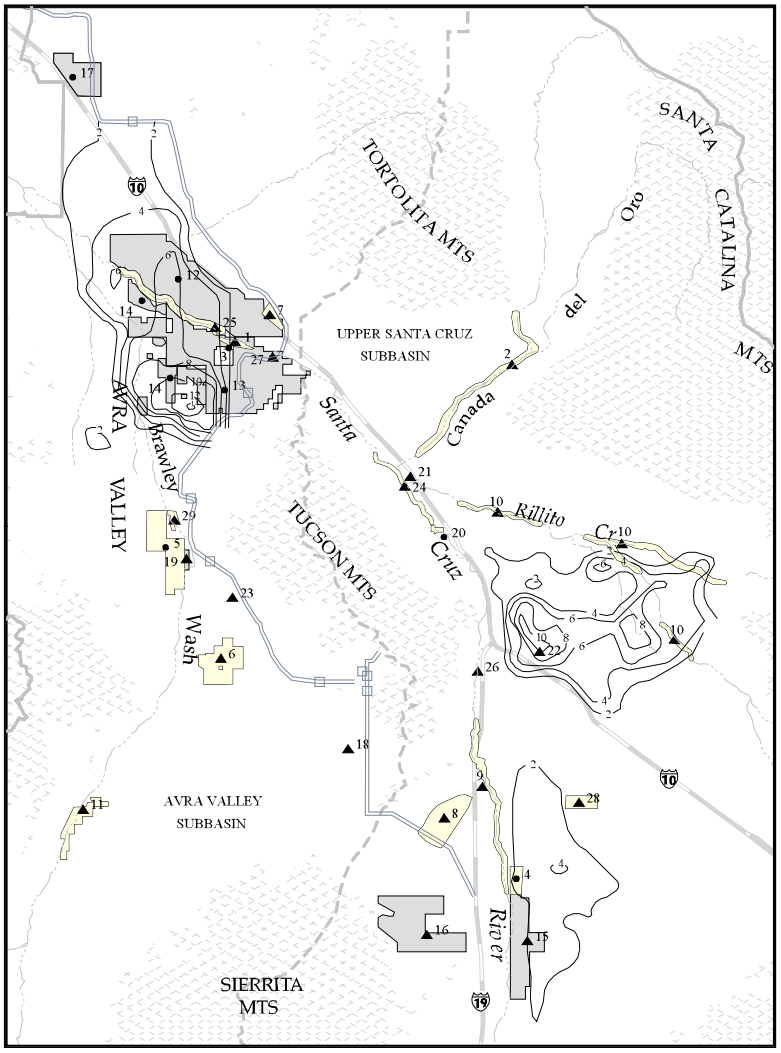
0 2 4 6 8 Miles

North

ORIGINAL SOURCE

Pima Association of Governments
Locations of Recharge Sites are Approximate





Existing

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Proposed

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16. ASARCO - Mission Mine
18. Pascua Yaqui
19. BKW at Mile Wide
21. Tanner Gravel Pit
22. Ajo Detention Basin
23. Avra Valley Gravel Pit
24. Santa Cruz River Managed Project
25. High Plains Effluent Recharge Project
26. Tucson Airport Remediation Project
27. BKW Siphon
28. Beehman
29. Manville-Brawley

- Groundwater Savings Facilities
- Underground Storage Facilities
- Existing Recharge Sites
- Proposed Recharge Sites
- Line of Equal Maximum Potential Subsidence By 2025 (In Feet)
- Hardrock
- Tucson AMA Boundary
- Rivers and Streams
- Interstates
- Subbasins
- CAP Canal
- CAP Pumping Stations

Figure 6

Land Subsidence Potential

Relative to Recharge Sites

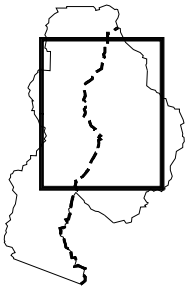
0 2 4 6 8 Miles

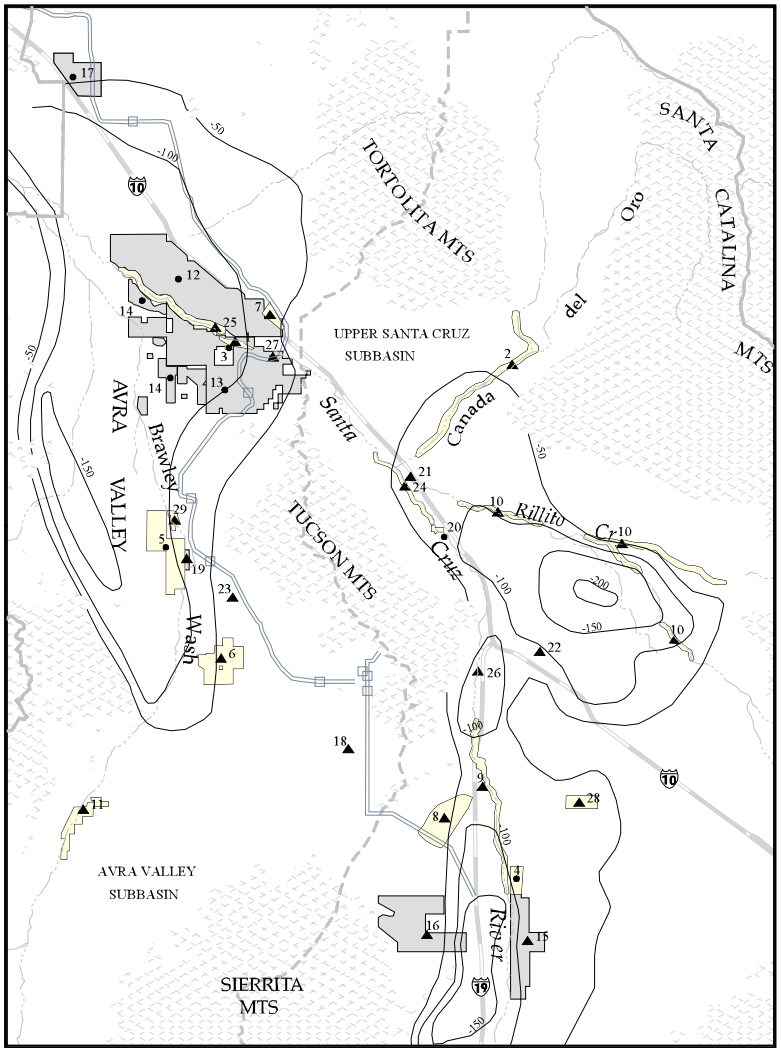
North

ORIGINAL SOURCE

Potential Subsidence:
U.S. Geological Survey
Water-Resources Investigations
Report 90-4178, 1990
Report 93-4196, 1994

Recharge:
Pima Association of Governments





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25. High Plains Effluent Recharge Project
26. Tucson Airport Remediation Project
27. BKW Siphon
28. Beehman
29. Manville-Brawley

Groundwater Savings Facilities
Underground Storage Facilities
Existing Recharge Sites
Proposed Recharge Sites
Line of Equal Change in Water Level (In Feet)
Hardrock
Tucson AMA Boundary
Rivers and Streams
Interstates
Subbasins
CAP Canal
CAP Pumping Stations

Figure 7

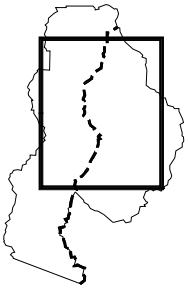
1940 to 1995 Water Level Changes
Relative to Recharge Sites

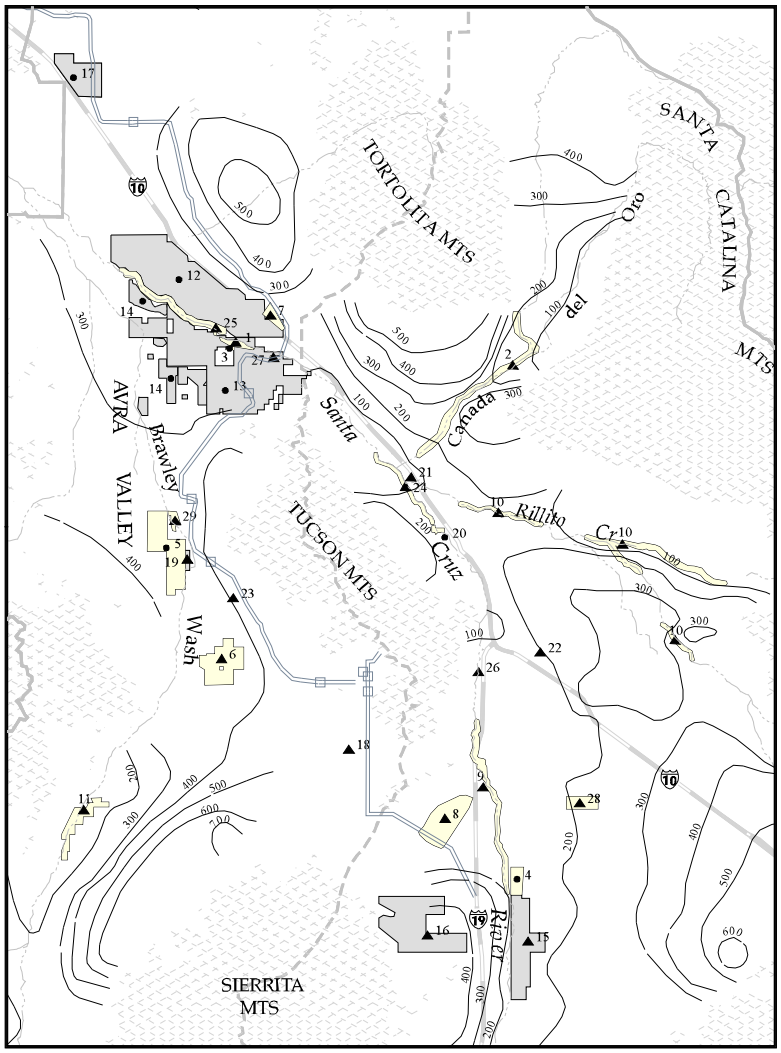
0 2 4 6 8
Miles
North

ORIGINAL SOURCE

Arizona Department of Water Resources
Geographic Information System

Recharge:
Pima Association of Governments





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26. Tucson Airport Remediation Project
27. BKW Siphon
28. Beehman
29. Manville-Brawley

- Groundwater Savings Facilities
- Underground Storage Facilities
- Existing Recharge Sites
- Proposed Recharge Sites
- Line of Equal Depth to Water (In Feet)
- Hardrock
- Tucson AMA Boundary
- Rivers and Streams
- Interstates
- Subbasins
- CAP Canal
- CAP Pumping Stations

Figure 8

1994 Depth to Water
Relative to Recharge Sites

0 2 4 6 8 Miles

North

ORIGINAL SOURCE

Arizona Department of Water Resources
Hydrology Division

Category III - Projects with good evidence of feasibility that are permitted (at least for large pilot operation) or are expected to be permitted in the near future.

Lower Santa Cruz Replenishment Project
Pima Mine Road Recharge Project
Central Avra Valley Storage and Recovery Project
San Xavier District Arroyos In-channel Recharge Project

Category II - Projects with sponsorship and substantial momentum but also substantial uncertainties regarding their operation as regional recharge facilities.

Cañada del Oro Recharge and Recovery Project
Santa Cruz River In-channel Recharge Project at San Xavier District
Farmers Investment Company (FICO) Groundwater Savings Project
Pascua Yaqui Recharge Project

Category I - Projects that lack sponsors or have been assigned lower priority than other projects by potential sponsors.

Pantano, Rillito and Tanque Verde In-channel Recharge Project
ASARCO Groundwater Savings Project
South Avra Valley Recharge Project
Brawley Wash Recharge Project

Capacity Criterion

Category III - Projects with the potential to recharge over 20,000 AF of water annually within ten years.

Central Avra Valley Storage and Recovery Project
Cañada del Oro Recharge and Recovery Project
Lower Santa Cruz Replenishment Project
Pima Mine Road Recharge Project
South Avra Valley Recharge Project
Brawley Wash Recharge Project
FICO Groundwater Savings Project

Category II - Projects with the potential to recharge 10,000 to 20,000 AF of water annually within ten years.

Avra Valley Recharge Project
BKW Farms Groundwater Savings Project
CMID Groundwater Savings Project

AVID Groundwater Savings Project
Kai Farms at Picacho Groundwater Savings Project

Category I - Projects with the potential to recharge up to 10,000 AF of water annually within the next 10 years.

San Xavier District Arroyos In-channel Recharge Project
Santa Cruz River In-channel Recharge Project at San Xavier District
Pantano, Rillito and Tanque Verde Recharge Project
ASARCO Groundwater Savings Project
Pascua Yaqui Recharge Project

Water Management and Related Benefits Criterion

Category IV - Projects contributing substantially to a majority of the listed water management and related benefits.

Cañada del Oro Recharge and Recovery Project
Pantano, Rillito and Tanque Verde Recharge Project
Central Avra Valley Storage and Recovery Project

Category III - Projects contributing to several listed water management and related benefits.

Pima Mine Road Recharge Project
San Xavier District Arroyos In-channel Recharge Project
Santa Cruz River In-channel Recharge Project at San Xavier District
FICO Groundwater Savings Project
ASARCO Groundwater Savings Project

Category II - Projects contributing to one or more listed water management and related benefits.

Avra Valley Recharge Project
Lower Santa Cruz Replenishment Project
BKW Farms Groundwater Savings Project
AVID Groundwater Savings Project
South Avra Valley Recharge Project
Pascua Yaqui Recharge Project
CMID Groundwater Savings Project

Category I - Projects with limited regional benefits beyond accrual of storage credits.

Kai Farms at Picacho Groundwater Savings Project
Brawley Wash Recharge Project

Each facility in a given category was given the same score. The scoring process and outcome is illustrated in Figure 9.

C. Project Capacity Analysis

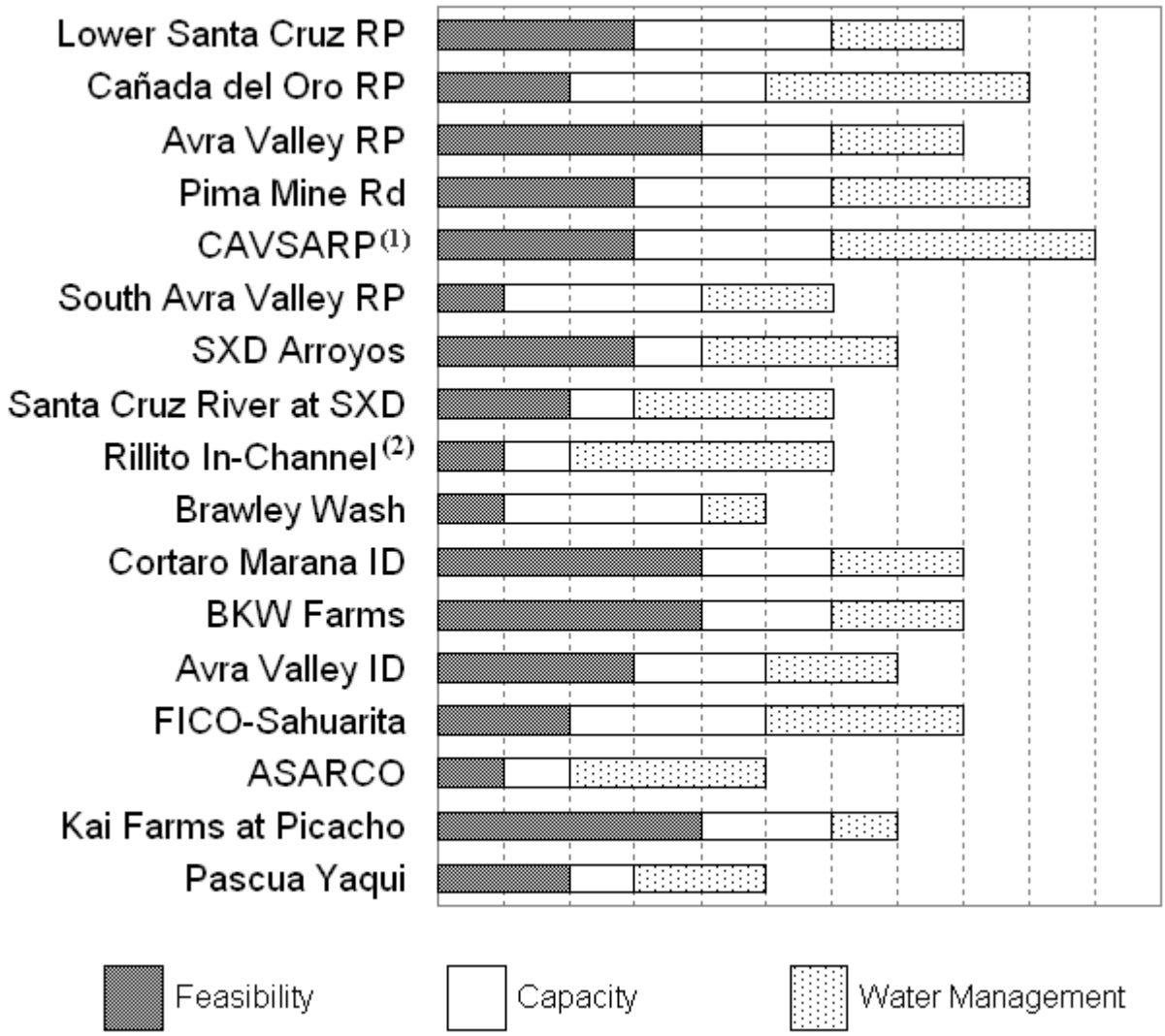
This phase of the Regional Recharge Plan includes all projects listed in feasibility categories IV, III and II. All of these projects have sponsorship commitment and were not disqualified on the basis of IPAG's selection criteria. All have the potential to contribute needed recharge capacity to the AMA, as well as to provide other recharge-related benefits. While the future demand for recharge capacity is uncertain, more CAP water is currently available for recharge than will be available in the future. This Plan is intended to support the on-going efforts of sponsoring entities to build sufficient recharge projects to allow storage of currently available water supply while building appropriate capacity for long-term storage needs.

Table 10 shows projections of developable recharge capacity based on current information and assumptions. Projects in Feasibility Category IV are assumed to be recharging by the year 2000 at their full projected capacity. Recharge from projects in feasibility categories II and III is estimated for the year 2000 and for the year 2007 based on what is known about the projects' phase-in time lines. Projects located on Indian reservations are summed separately because, in the absence of an IGA governing storage credits, recharge in these projects can not be used to meet the demand of municipal water providers

D. Ability to Meet Recharge Needs

As is shown in Table 10, it is only possible to utilize all of the CAP water available if virtually all of the projects are constructed, including those on Indian reservations. This would require massive capital investment, and it is probably overly optimistic to assume it could be done by 2007. The "high end" recharge scenario presents a more probable maximum developable capacity of 173,500 AF by 2007 (Table 5).

Figure 9. Recharge Project Assessment



(as of July 1998*)

Projects were selected from a longer list of 35 and are considered most likely to meet regional objectives.

* Project assessments are expected to change in absolute and relative terms over time as projects develop.

(1) CAVSARP rates highly from a water management perspective because the project is intended to offset use of groundwater wells in the Central Wellfield.

(2) The Rillito In-Channel Project evaluated in this report includes portions of Rillito Creek and the Pantano and Tanque Verde washes and is not the same as the pilot project currently being considered by the City of Tucson, although the two project proposals share a stream segment in common.

ID - Irrigation District, RP - Recharge Project, CAVSARP - Central Avra Valley Storage and Recovery Project, SXD - San Xavier District (of the Tohono O'odham Nation)

Table 10. IPAG Projections of Developable Recharge Capacity Based on Current Assumptions/Information

Groundwater Savings Facilities	2000	2007
BKW Farms (RRC #13)	16,000	16,000
Cortaro-Marana Irrigation District (RRC #12)	20,000	20,000
Kai @ Picacho (RRC #17)	11,000	11,000
BKW @ Mile Wide Road ****	600	600
Avra Valley Irrigation District (RRC #14)	12,500	12,500
Farmers Investment Company (FICO) (RRC #15)	20,000	20,000
ASARCO (RRC #16)	0	10,000
TOTAL GSF	**80,100**	**90,100**
Underground Storage Facilities	2000	2007
Avra Valley (basins) (RRC #3)	11,000	11,000
Lower Santa Cruz (basins) ** (RRC #1)	13,000	30,000
Pima Mine Road (basins) (RRC #4)	10,000	30,000
CAVSARP (basins) (RRC #5)	15,000	30,000
CDO - Big Wash (basins) *** (RRC #2)	0	30,000
Pantano, Rillito and Tanque Verde (in-channel) (RRC #10)	0	10,000
TOTAL USF	**49,000**	**141,000**
TOTAL NON-INDIAN	**129,100**	**221,100**
Indian Water Recharge*	2000	2007
San Xavier District (basins) *****	0	15,000
San Xavier District Arroyos (in-channel) (RRC #8)	9,000	9,000
San Xavier District Santa Cruz (in-channel) (RRC #9)	7,000	7,000
Pascua Yaqui (basins) (RRC # 18)	10,000	10,000
TOTAL INDIAN	**26,000**	**41,000**
TOTAL RECHARGE	**155,100**	**272,100**

* ADWR permits not required on Indian lands. IGA needed to allow storage credit accrual and recovery by non-Indians.
** May be expanded to include managed in-channel component.
*** Design includes spreading basins as well as possible managed in-channel.
**** Not evaluated in recharge site assessment, but included here to match recharge capacity to CAP supply.

CAVSARP - Central Avra Valley Storage and Recovery Project, CDO - Cañada del Oro, RRC - Regional Recharge Committee GSF - Groundwater Savings Facility, USF - Underground Storage Facility, IGA - Intergovernmental Agreement, CAP - Central Arizona Project, ADWR - Arizona Department of Water Resources